

Power Quality Improvement in Distribution System using D-Statcom

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Abstract— This thesis aims to about the performance of D-STATCOM, to mitigate voltage sag hence Improve the power quality of the power system. Various loads like Starting of induction motor, Transient fault& Arc furnace will create Voltage sag in the power system, by using D-STATCOM, connected at the point of common Coupling we can provide the compensation &mitigate the sag. A power quality problem is an occurrence manifested as a nonstandard voltage, current or frequency that results in a failure or malfunction of the equipment at user-end, Utility distribution networks, sensitive industrial loads & critical commercial operations suffer from various types of outage & service interruption, which can cost significant financial losses. Due to advancement in power electronic technology, usage of Converter, Inverter, SMPS, UPS is increased exponentially, which are nonlinear loads &increased Harmonics distortion in system.

Key words: Voltage Sag, Induction Motor, Transient Fault, Arc Furnace, D-STATCOM

I. AIM

The aim of this project is power quality improvement in distribution system by using a device which is known as D-STATCOM which is distribution static compensator.

II. OBJECTIVE

- 1) To cancel the effect of harmonics due to load so that the current drawn from the source is nearly sinusoidal.
- 2) To help maintain near unity power factor by canceling the effect of poor load power factor.
- 3) To help offset the effect of unbalanced loads such that the current drawn from the source is balanced.

III. INTRODUCTION

In the present generation, Power Quality has become one of the most significant problems. Due to the use of different types of sensitive electronic equipments, Power Quality issues have drawn substantial attention from both utilities and users.

Increased use of non-linear loads and the proliferation of power electronic based Equipment has led to many problems in the power distribution network. Solid state switching devices such as thyristors and other switches are used in Uninterruptible Power Supplies (UPSs), variable speed drives etc. Because of their inherent non-linearity, they draw reactive power and harmonic current components from the utility. This could lead to low system efficiency and poor power factor, apart from harmonic pollution of the system.

Harmonics and non-linear loads from a single customer can affect the quality of power received by other customers. Low power factor loads can cause power losses at the distribution feeder.

When we are using a non-linear load in a power system, the fundamental sinusoidal waveform of current will change. The main Power Quality deviations are happened by short-circuits, harmonic distortions, notching, voltage sags, voltage flickers, voltage swells and transients due to switching of load.

Various methods have been applied to reduce or mitigate voltage sags. The conventional approach to this solution has been the use of passive power filters. Though they are a low-cost solution, there are disadvantages to using them, the main risk being that of resonance with the system impedance. They are also bulky and overcompensation can lead to a lower power factor .Active power filters can overcome these problems.

It is necessary to control the power flow in transmission & distribution networks. Previously, few conventional approaches are adopted like.

- 1) Automatic generation control
- 2) Excitation (flux) Control
- 3) Phase shifting transformer
- 4) Tap changers

IV. POWER QUALITY

“The concept of powering & grounding sensitive electronics equipment in a manner suitable to the equipment” it also defines as, “ set of electrical boundaries that allows a piece of equipment to function in intended manner without any significant loss of performance or life expectancy power quality simply means if equipment operates correctly & reliably without being damaged or stressed , we would say the electrical power is of good quality, on other hand , if electrical equipment malfunction or operate unreliably & damaged, we would suspect that power quality is poor. Thus power quality broadly refers to maintaining sinusoidal waveform of voltage & current at rated magnitude & frequency.

A simpler and perhaps more concise definition might state: “Power quality is a set of electrical boundaries that allows a piece of equipment to function in its intended manner without significant loss of performance or life expectancy.” This definition embraces two things that we demand from an electrical device: performance and life expectancy. Any power-related problem that compromises either attribute is a power quality concern. In light of this definition of power quality, this chapter provides an introduction to the more common power quality terms. Along with definitions of the terms, explanations are included in parentheses where necessary. This chapter also attempts to explain how power quality factors interact in an electrical system.

A. The Power Quality Issues

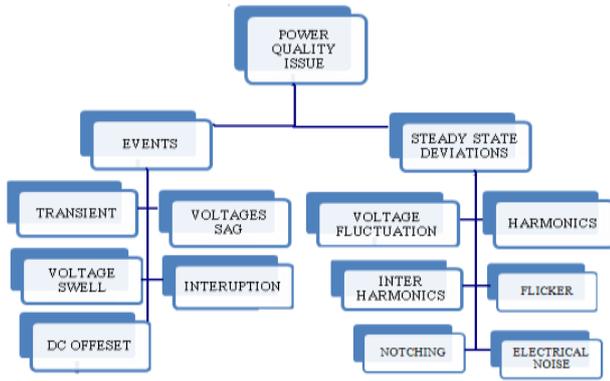


Fig. 1: Power quality issues

V. PROBLEM DEFINITION

A voltage sag can be define as an r.m.s (root mean square) reduction in the AC voltage at the power frequency, for duration from a half cycle to a few second.

A voltage swell can be define as an r.m.s (root mean square) increase in the AC voltage at the power frequency, for duration from a half cycle to a few second.

Voltage outage is define as complete loss of voltage or current for time period, due to faults and reclose operation the momentarily interruption in supply (few cycles) occurred. It is also term as momentary outage.

Transient is define as “sub cycle disturbance in the A.C. waveform, evident by sharp, brief Discontinuity of the waveform.

Notch is defined as,” disturbance in the A.C. waveform, evident by sharp, brief discontinuity of the waveform lastingness than half cycle (mostly occurs just once in half cycle)”

Harmonic is defined as sinusoidal component of a periodic wave having a frequency that is an integral multiple of fundamental frequency.

VI. IMPLEMENTATION AND DETAIL

A. Voltage Sag

One of the most common power frequency disturbances is voltage sag. By definition, voltage sag is an event that can last from half of a cycle to several seconds. Voltage sags typically are due to starting on large loads, such as an electric motor or an arc furnace. Induction motors draw starting currents ranging between 600 and 800% of their nominal full load currents. The current starts at the high value and tapers off to the normal running current in about 2 to 8 sec, based on the motor design and load inertia. Depending on the instant at which the voltage is applied to the motor, the current can be highly asymmetrical.

As Per standards 1159-1995, recommended practices for power quality is “Decrease in RMS value of voltage or current at power frequency for duration from half cycle to one minute, reported variation between 1 P.U. to 0.9 P.U.

Type of voltage sag	Duration	Magnitude
Instantaneous	0.5 – 30 cycle	0.1-0.9pu
Momentary	30cycle – 3second	0.1-0.9pu
Temporary	3second -1min	0.1-0.9pu

Table 1: Voltage Sag

The Voltage sag or Dip is caused by abrupt increase in reactive loading such as switch on the motors, switch on the transformer, severe short circuit fault.

Voltage sag is most of the time described by two essential characteristics, one magnitude and one duration. However, the sag magnitude is not constant, due to the induction motor load present in many industrial systems.

Voltage sags are most common power disturbances; It contributes more than 80% of power quality problems. Voltage sags are not tolerated by sensitive equipment used in used in industrial plants such as process controllers, programmable logic controllers [PLC], Adjustable speed drives [ASD] and robotics. It has been reported that high intensity discharge lamps used for industrial illumination get extinguished at voltage sag of 20%, the other equipments like PLC & ASD are adversely affected by 10% of voltage sag.

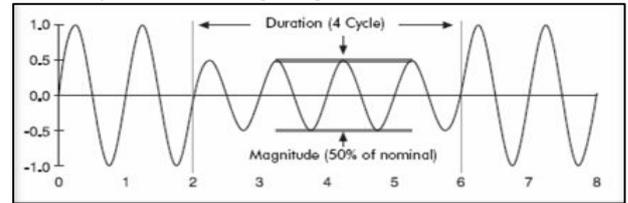


Fig. 2: Voltage Sag

B. Sag Causes - Distribution System

Similar to the transmission system cause, weather (lighting, wind, ice), animal contact, contamination of insulators, construction accidents, motor vehicle accidents, falling or contact with tree limbs can result in voltage sags. Such faults may be 3-phase, line-to-line, or single line-to-ground. The 3-phase faults are the most severe, but are relatively unusual. "Single line-to-ground faults on the utility system are the most common cause of voltage sags in an industrial plant". Preliminary results from the IEEE study indicate that most important cause of momentary voltage sags is lightning strikes. In the majority of sags, the voltage drops to about 80% of nominal value on the parallel feeders, while the faulted feeder may have a lower sag value, or may result in an outage if the fault cannot be cleared. Distribution system sags tend to cluster around several duration ranges, based on the fault protection schemes: 6-20 cycles (typical distribution fault clearing times, 30-60 cycles (the instantaneous reclosing time for breakers) or 120-600 cycles (the delayed reclosing time for breakers).A typical distribution substation is show in Figure 4. A fault on the 115KV primary side of the transformer (transmission level) will effect all of the feeders, as the 13.8KV bus voltage will be lowered. A fault on a single feeder will most likely cause an outage to loads on that feeder, as well as sag on the parallel feeders. The closer the fault is to the substation bus, the more of an effect it will have on the parallel feeders.

When the fault occurs on a fused branch of a distribution feeder, The fuse blows and Customer located on that branch will experience an outage, which will last until whichtime that the fuse is replaced. If the breaker/reclose operates during the fault, all the customers on that feeder experience an interruption of a duration that depends on the reclose setting.

C. Voltage Swell

As per 1159-1995, voltage swell is define as rise in RMS voltage level to 110% -180% of nominal ,at power frequency for duration of half cycle to one minute. It is also short duration voltage variation phenomena, which is opposite to voltage sag or dip.

Types of voltage swell	Duration	Magnitude
Instantaneous	0.5 – 30cycle	1.1 – 1.8pu
Momentary	30cycle 3second	1.1 – 1.4pu
Temporary	3second - 1min	1.1 – 1.2pu

Table 2: Voltage Swell

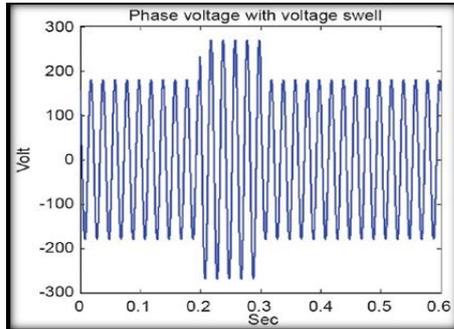


Fig. 3: Voltage Swell

The performance of DVR for a voltage swell condition is investigated. Here, the supply voltage swell is generated. The supply voltage amplitude is increased about 125% of nominal voltage. The injected voltage that is produced by DVR in order to correct the load voltage and the load voltage, respectively. As can be seen from the results, the load voltage is kept at the nominal value with the help of the DVR. Similar to the case of voltage sag, the DVR reacts quickly to inject the appropriate voltage component (negative voltage magnitude) to correct the supply voltage.

The performance of the DVR with an unbalanced voltage swell . In this case, two of the three phases are higher by 25% than the third phase . The injected voltage that is produced by DVR in order to correct the load voltage, respectively. Notice the constant and balanced voltage at the load throughout the simulation, including during the unbalanced voltage swell event.

Voltage swell is described as a drop of 10-90% of the rated system voltage lasting for half a cycle to one minute. The causes of voltage swell are.

- 1) Voltage swell are caused by system faults.
- 2) It can also be caused by energisation of heavy loads.
- 3) In the swell waveform obtained above it can be observed that there is an increase in value of R.M.S voltage during swell. The error signal will show smooth variation during swell period and finally the adoption error will be reduced to zero.

VII. VOLTAGE OUTAGE (INTERRUPTION)

Define as complete loss of voltage or current for time period, Due to faults & reclose operation the momentarily interruption in supply(few cycles) occurred. It is also term as momentary outage. It has adverse effect on sensitive loads like process controllers, programmable logic controllers [PLC], Adjustable speed drives [ASD] and robotics.

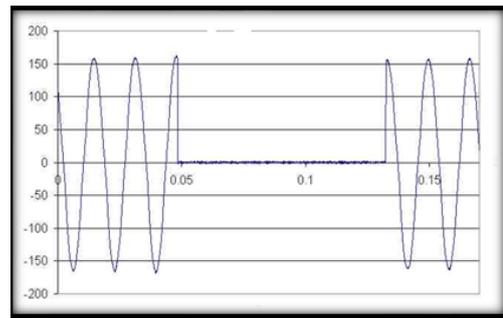


Fig. 4: Voltage Outage

A. Transient

Transient is defined as a subcycle disturbance in the AC waveform that is discernible as a sharp discontinuity of the waveform. The definition states that transients are subcycle events, lasting less than one cycle of the AC waveform. Inclusion of the term subcycle is for the sake of definition only. Routinely we see transients that span several cycles. To satisfy the absolute definition, the transient occurring in the next cycle is not considered an extension of the transient in the previous cycle. This approach allows us to isolate the disturbance on a cycle-by-cycle basis for ease of analysis and treatment. Subcycle transients are some of the most difficult anomalies to detect and treat. Their occurrence can be random, and they can vary in degree depending on the operating environment at the time of occurrence. Their effect on devices varies depending on the device itself and its location in an electrical system.

Transients are difficult to detect because of their short duration. Conventional meters are not able to detect or measure them due to their limited frequency response or sampling rate. For example, if a transient occurs for 2 sec and is characterized by a frequency content of 20 kHz, the measuring instrument must have a frequency response or sampling rate of at least 10 times 20 kHz, or 200 kHz, in order to fairly describe the characteristics of the transient. For faster transients, higher sampling rates are necessary, we will look into what is involved in selecting and setting up instrumentation for measuring electrical transients.

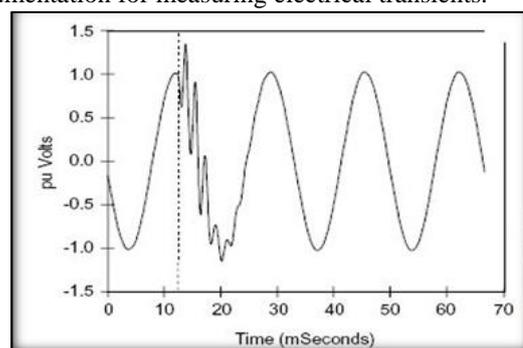


Fig. 5: Transient

Many different terms are associated with transients, such as spikes, bumps, power pulses, impulses and surges. While some of these terms may indeed describe a particular transient, such terms are not recommended due to their ambiguity. We will use the term transient to denote all subcycle events and ascribe certain characteristics to these events, such as overvoltage, notch, noise, and ring. It may be that what we call transient is not as important as remembering that the underlying causes of the various

transient events differ, as do the cures for the ill effects produced by the transients.

It is define as “sub cycle disturbance in the A.C. waveform, evident by sharp, brief Discontinuity of the waveform”.

B. Notch/Spikes

It is define as, disturbance in the A.C. waveform, evident by sharp, brief discontinuity of the waveform lastingness than half cycle (mostly occurs just once in half cycle).

Notching is a periodic voltage disturbance caused by electronic devices, such as variable speed drives and arc welders under normal operation.

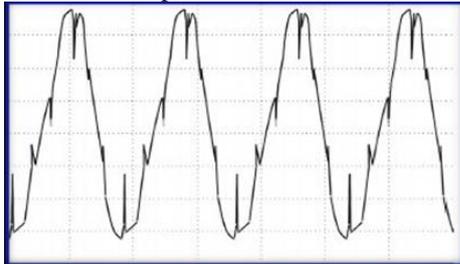


Fig. 6: Notching

C. Harmonics

It is define as sinusoidal component of a periodic wave having a frequency that is an integral multiple of fundamental frequency, The harmonics create over heating in equipment, reduce the efficiency by increasing the losses. For metering & comparison of harmonic contents of waveform the parameter is define as a total harmonics distortion.

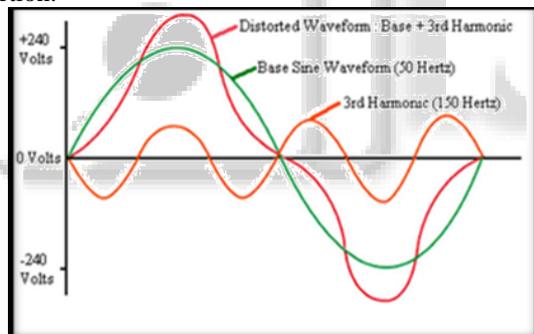


Fig. 7: Harmonics

When we talk about ac we are talking about alternating current. The voltage pushing that current through the load circuit is described in terms of frequency and amplitude. The frequency of the current will be identical to the frequency of the voltage as long as the load resistance/impedance does not change. In a linear load, like a resistor, capacitor or inductor, current and voltage will have the same frequency. As long as the characteristics of the load components do not change, the frequency component of the current will not change. When we deal with non-linear loads such as switching power supplies, transformers which saturate, capacitors which charge to the peak of the supply voltage, and converters used in drives, the characteristics of the load are dynamic. As the amplitude of the voltage changes and the load impedance changes, the frequency of the current will change. That changing current and resulting complex waveform is a result of these load changes. The complex current waveform can be described by defining each component of the waveform. The

component of any waveform can be defined in terms of dc, and all frequencies from 0 to infinity. The frequencies that are normally dealt with using drives are 50 and 60 Hertz. By definition, these frequencies are termed fundamental in their respective distribution systems.

D. How can harmonic currents affect AC drive sales?

Our principle concern should be how to deal with the concern or “fear” that our customers are likely to have regarding harmonic currents. We need to provide as much “good” information as possible without confusing the customer. These basic facts can be given to the customer concerned with harmonic currents are:-

- 1) Harmonic currents can cause overheating of distribution system equipment.
- 2) Harmonic currents are caused by any electrical equipment that used SMPS.
- 3) Distribution system loading by non-linear equipment can cause older dry type transformers to overheat if not derated.
- 4) Lighting accounts for 55% of all electrical power used. An estimated 90% of that power is controlled by some type of switching mode power supply (SMPS). That means that 50% of all power used can have harmonic currents overloading transformers, capacitors and other components on the distribution system.
- 5) Motors account for 40% of all electrical power used. An estimated 20% of that power is controlled by some type of 3 phase SMPS. That means that 8% of all power used for controlling motors can have harmonic currents overloading transformers, capacitors and other components on the distribution system.
- 6) Harmonic current will cause voltage distortion The amount of distortion is much less than the distortion caused by the normal line current. Voltage distortion by high frequencies will be a percentage of the voltage drop caused by the fundamental current. A 5% drop in line voltage due to the fundamental load current will be increased by the 5th harmonics by 20% of 5% or an additional 1%.
- 7) Transformers, circuit breakers, and other distribution system components ratings within any facility Should be reviewed based on the original selection and any changes or additions in non-linear loads.
- 8) Single phase loads, such as lighting loads should be reviewed to determine what level of harmonic current distortion already exists in a system before adding additional non-linear loads to that system.
- 9) The different types of AC drives on the market, the AC drive which causes the lest amount of harmonic current and voltage distortion over the operating speed range is a PWM AC drive which contains an internal dc bus reactor. The second best is a PWM AC drive with an AC line reactor before the drive.
- 10) The use of line filters before a drive will add more losses to the electrical system and could create line ringing and large voltage transients. These conditions could results in greater damage to other components on the distribution system. Even if correctly designed for an installation, the filter may have to be modified every time an additional piece of equipment is added to that distribution system.

VIII. D-STATCOM

A. Definition

The D-STATCOM is a shunt connected reactive power compensation device that is capable of generating and /or absorbing reactive power and in which the output can be varied to control the specific parameters of an electrical power system. It is in general a solid state switching converter capable of generating or absorbing independently controllable real and reactive power.

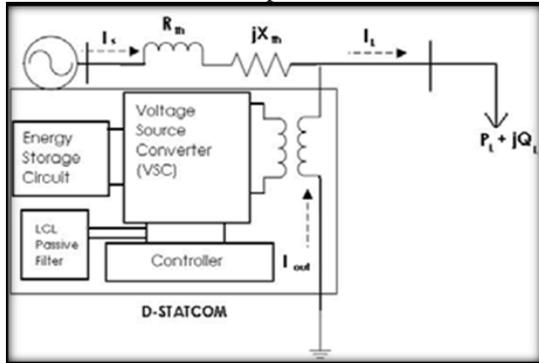


Fig. 9: D-STATCOM

The main aims of the D-STATCOM are:

- 1) To cancel the effect of harmonics due to load so that the current drawn from the source is nearly sinusoidal.
- 2) To help maintain near unity power factor by canceling the effect of poor load power factor.
- 3) To help offset the effect of unbalanced loads such that the current drawn from the source is balanced.

B. Operation of D-STATCOM

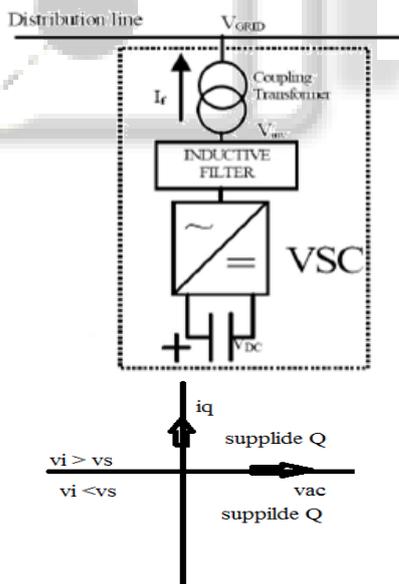


Fig. 10: Operation of D-STATCOM

The D.C. Capacitor is used as a energy source, This D.C. voltage is converted into three phase through voltage source inverter.

The switching of IGBT is done by PWM technique. Switching ripples can be damped by providing filters. The exchange of reactive power between the converter and the ac system can be controlled by varying the amplitude of the 3-phase output voltage of the converter.

When STATCOM voltage $[V_i]$ is higher than $[V_s]$ system voltage, Then it will feed the reactive power to the system & When $V_i < V_s$, then system will supply reactive power to charge the capacitor

IX. SIMULATION

A. Simulation circuit of Transient Fault

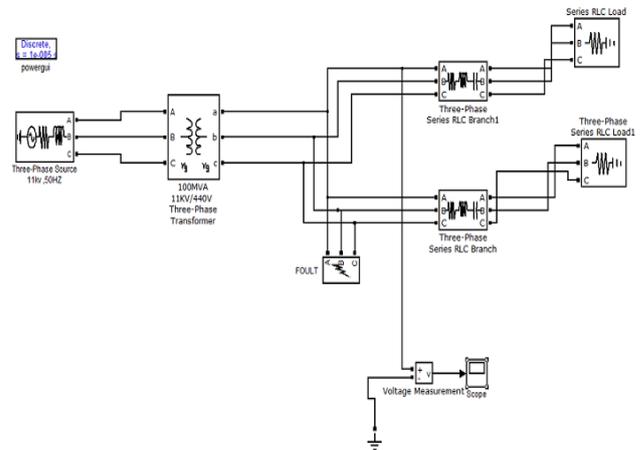


Fig. 11: Simulation Circuit of Transient Fault

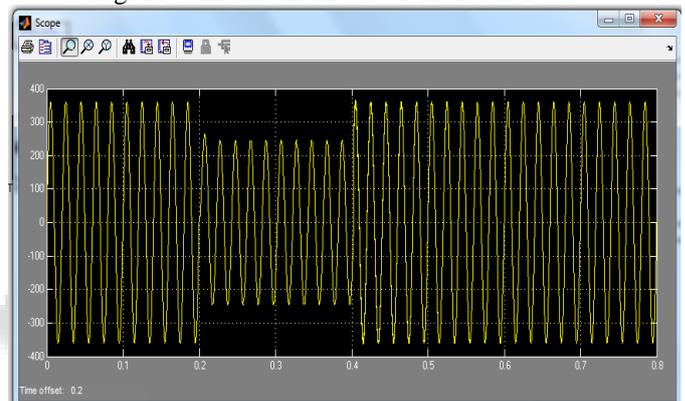


Fig. 12: Waveform of Transient Fault

B. Simulation circuit of Induction motor

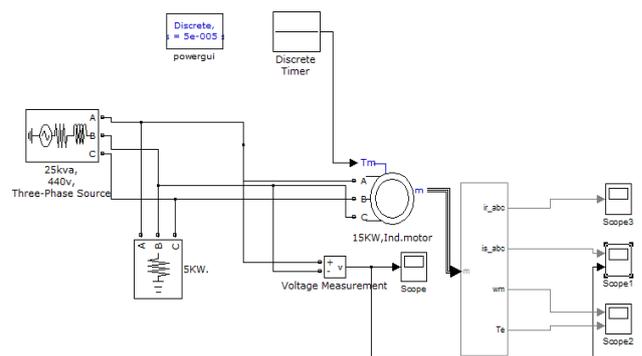


Fig. 13: Simulation Circuit of Induction Motor

A dynamic model of the induction motor developed using Simulink / MATLAB that is beneficial for use as a teaching tool in electric machines and power electronics courses, or that can be used as a research tool in the laboratory is presented. The model can be used to study the dynamic behavior of the induction motor, or can be used in various motor-drive topologies with minor modifications. The motor model presented is based on the T-type d-q model of the induction motor. A block model approach is used in the

construction of the motor model that will allow users of the model to resolve reference frame theory issues. The model developed is intuitive, easy to use, and allows all motor parameters to be easily accessed for monitoring and comparison purposes. The model presented is capable of being used with various inverter topologies and PWM schemes with minor modifications.

C. Waveform of Induction Motor Stator Voltage & Current

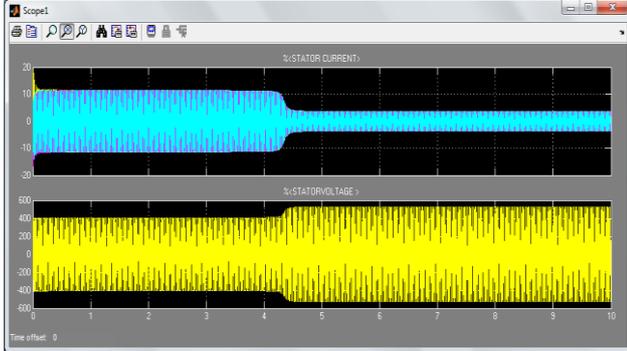


Fig. 14: Waveform of Induction Motor Stator Voltage & Current

D. Simulation of Arc Furnace

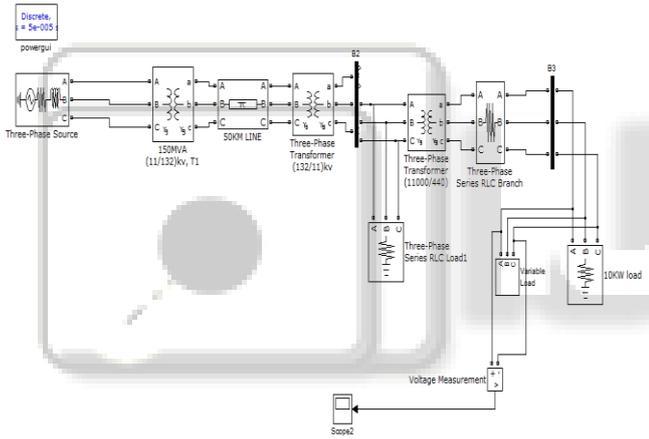


Fig. 15: Simulation of ARC Furnace

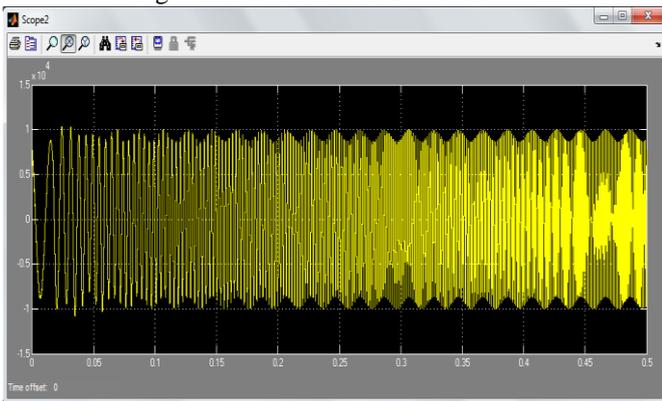


Fig. 16: Waveform of ARC Furnace

E. Simulation and Analysis

The simulation data was generated in MATLAB based on the model in table 2 as per IEEE standards. All the four classes of different voltage swell events or disturbance, namely undisturbed sinusoid(normal), swell and its different categories the signal generation models and their control parameters. Types of swell simulation results cases of each

class with different parameters were generated for training and another 25 cases were generated for testing. Both the training and testing signals are sampled at 200 points/cycle and the normal frequency is 50 Hz. Fifteen power frequency cycles which contain the type of swell time duration typical amplitude

- 1) Momentary swell 30 cycles to 3 sec of 1.1 p.u to 1.4 p.u.
- 2) Temporary swell 3 sec to 1 min of 1.1 p.u to 1.4 p.u.
- 3) Long-term Over Voltage 1min of 1.1 p.u to 1.2 p.u.

X. CONCLUSION

From this project we conclude that power quality problem in distribution such as voltage sag, voltage swell, transient, voltage outage etc can be solved by using D-STATCOM device, which is power electronic based device in distribution system in MATLAB simulation version 2013.

The simulation results show clearly the performance of a DVR in mitigating voltage sags and swells. The DVR handles both balanced and unbalanced situations without any difficulties and injects the appropriate voltage component to correct rapidly any anomaly in the supply voltage to keep the load voltage balanced and constant at the nominal value.

XI. LITERATURE REVIEW

The study of literature for the thesis commence with the detection voltage sag, swell arises due to linear & non linear load and fuzzy logic based control of D STATCOM.

A. Noramin Ismail, 2 Wan Norainin Wan Abdullah "Enhancement of Power Quality in Distribution System Using D-STATCOM" 978-1-4244-7128-7/10/\$26.00 ©2010 IEEE

This paper presents the enhancement of voltage sags, harmonic distortion and low power factor using Distribution Static Compensator (D-STATCOM) with LCL Passive Filter in distribution system. The model is based on the Voltage Source Converter (VSC) principle. The D-STATCOM injects a current into the system to mitigate the voltage sags. LCL Passive Filter was then added to D-STATCOM to improve harmonic distortion and low power factor.

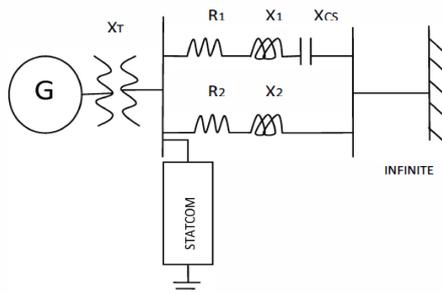
D-STATCOM is one of the custom power devices which locate shunt in network and applied to mitigate voltage sag and voltage swell. The D-STATCOM has emerged as a promising device to provide not only for voltage sag mitigation but also for a host of other power quality solutions such as voltage stabilization, flicker suppression, power factor correction, and harmonic control.

D-STATCOM is a shunt device that generates a balanced three-phase voltage or current with ability to control the magnitude and the phase angle. The VSC converts the dc voltage across the storage device into a set of three-phase ac output voltages. These voltages are in phase and coupled with the ac system of network through the reactance of the coupling transformer.

B. S.T.Nagarajan, Narendra kumar .” fuzzy logic based control of STATCOM for Mitigation of SSR””978-1-4673—0934-9/12@2012 IEEE

STATCOM a FACTS device is a second generation Static VAR Compensator (SVC) based on voltage sourced inverter and has better reactive power support even at low voltages.

Design of Fuzzy logic controller does not depend on the system model. This eliminates the need to Linearise the power system model to tune the parameters of controller. The entire power system components are represented with their nonlinear equations/models for the IEEE second benchmark power system model for SSR studies shown in Fig.



STATCOM is a widely used FACTS device for reactive power generation, voltage support and improving steady state stability of power system. In this paper a Fuzzy logic Input: Triangular membership supplementary controller for STATCOM to damp Sub synchronous oscillations has been presented for series compensated system. The Fuzzy logic controller has advantage over conventional controllers as the exact knowledge of the system is not required. With the proposed FLC supplementary control signal for STATCOM.

C. Sathish Babu P, Kamaraj N” Performance Investigation of Dynamic Voltage Restorer using PI and Fuzzy Controller” 978-1-4673-6030-2/13 ©2013 IEEE

Thus the proposed DVR has the ability to mitigate various levels of voltage sag and different types of faults. Prove that the control scheme provides an accurate tracking of the voltage reference and a very fast transient response. Both the controllers exhibits good performance and minimize the THD level. It is found that FLC gives better performance with THD of 0.42% where as PI gives 0.46% THD.

The increase in KVA rating of injection transformer and DC storage value effectively compensates the voltage sag and reduce the THD level. However, higher value of DC storage and transformer rating makes it more expensive. The efficacy of a DVR system mainly depends upon the rating of DC storage capacity, injection transformer rating and the load.

D. K.R.Suja, I Jacob Raglend.” Fuzzy Based Unified Power Quality Conditioner for Power Quality Improvement” 2013 International Conference on Circuits, Power and Computing Technologies [ICCPCT-2013]987-1-4673-4922-2/13/2013 IEEE

Fuzzy logic is the part of artificial intelligence or machine learning which interprets the human action. Computers can interpret only true or false values but a human being can reason the degree of truthiness or degree of falseness. Fuzzy

models interpret the human actions and are also called intelligent systems.

Fuzzification is the process of changing a real scalar value into a fuzzy value. This is achieved with the different types of fuzzifiers. Fuzzy logic is a rule-based system. These rules are stored in the knowledge base of the system. The input to the fuzzy system is a scalar value that is fuzzified.

E. Amin Nazarloo, Seyed Hossein Hosseini” Mitigation of Voltage Sags in a Sample Distribution System Using Flexible D-STATCOM” in Tabriz power distribution company, Tabriz,iran

Voltage sags are the most important power quality(PQ) problems that many industries and utilities face it. It contributes more than 80% of power quality problems that exist in power systems. There are three types of faults in power networks that cause to voltage sag, such as shunt, series and simultaneous faults. Shunt fault types involving one or two phases and ground are. A single line-to-ground fault, double line-to-ground fault , line-to-line fault, three line-to-ground fault. The series type faults are “One conductor opens ,Two conductors open, Three conductors open.

Various methods have been applied to reduce or mitigate voltage sags. The conventional methods From 1988, custom power is introduced as a solution to power quality problems.

D-STATCOM is one of the custom power devices which locate shunt in network and applied to mitigate voltage sag and voltage swell. The D-STATCOM has emerged as a promising device to provide not only for voltage sag mitigation but also for a host of other power quality solutions such as voltage stabilization, flicker suppression, power factor correction, and harmonic control.

D-STATCOM is a shunt device that generates a balanced three-phase voltage or current with ability to control the magnitude and the phase angle. The VSC converts the dc voltage across the storage device into a set of three-phase ac output voltages. These voltages are in phase and coupled with the ac system of network through the reactance of the coupling transformer.

F. Francisco Jurado, Manuel Valverde , Jose Carpio “VOLTAGE SAG CORRECTION BY DYNAMIVCO LTAGE RESTORER BASEDO N FUZZY LOGIC CONTROL’ CCECE 2003 - CCGEI 2003, Montr&al, May, mai 2003

The common PI control, the control parameters are fixed, so the PI law can only guarantee good performance in a local area since the DVR is non-linear. On the other hand, this paper demonstrates that the transient response of the FL control is better than that of PI.

When the DVR and PI control are in operation the voltage sag is mitigated almost completely, and the voltage at the sensitive load point is maintained at **95%**, When the DVR and FL control are in operation the sensitive load point is maintained at **98%**.

REFERENCE

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